Voyager Bulletin

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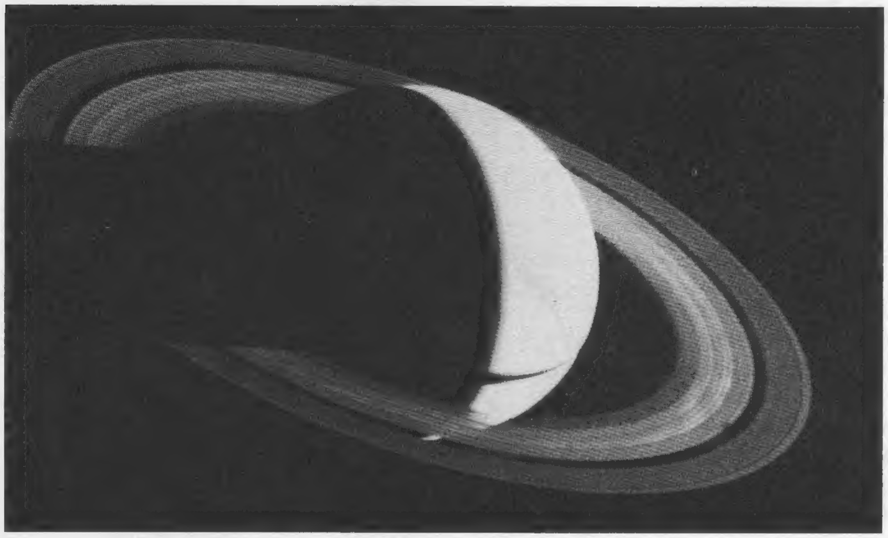

POST-ENCOUNTER — Looking back, Voyager 1 observed Saturn and its rings from this unique perspective four days after flying past the planet. A few of the spoke-like ring features discovered by Voyager appear in the rings as bright patches in this image. At left, Saturn's shadow falls upon the rings, and the bright Saturn crescent is seen through all but the densest portion of the rings. The ring shadows are seen near the planet's equator. From Saturn, Voyager 1 is on a trajectory taking the spacecraft out of the ecliptic plane, away from the Sun and eventually out of the solar system (by about 1990). Voyager 1's flight path through intergalactic space is in the direction of the constellation Ophiuchus.

Update

Voyager 1 is continuing its post-encounter observations of the Saturn system. The spacecraft is now about 29 million kilometers (18 million miles) beyond the planet, travelling with a heliocentric velocity of about 21.6 kilometers per second (more than 48,000 miles per hour). Radio signals from the ship reach earth 83 minutes after transmission, travelling about 1.5 billion kilometers (930 million miles) to get here.

Voyager 2, eight and one-half months from its closest approach to Saturn in August 1981, is in good health and operating well. It is about 248 million kilometers (154 million miles) from the planet, travelling with a heliocentric velocity of about 16.6 kilometers per second (37,000 miles per hour). Radio signals between earth and Voyager 2 travel about 69 minutes each way. Voyager 2's distance to earth is over 1.2 billion kilometers (770 million miles).

Post-Encounter Activities

Voyager 1's post-Saturn encounter observations will continue through December 15, 1980. Aside from calibrations, no further imaging observations are planned after December 19, but the fields and particles sensing instruments will continue to be operated and to sample the interplanetary medium.

Wide-angle imaging frames taken on November 16 - 18 as Voyager 1 soared up and away from Saturn have been assembled into a post-encounter time-lapse movie of the planet and rings rotation. Voyager 1 put about 2.0 million miles between itself and the planet while taking these pictures. The B-ring spokes, which appeared as dark streaks in inbound photographs, appear bright in outbound photographs, indicating that they scatter light strongly in a forward direction. Infrared observations occurred simultaneously with these imaging sequences.

Through mid-December, the spacecraft will continue a daily cycle of Saturn imaging, ultraviolet observations of the Saturn system, infrared composition measurements of the planet, celestial mechanics measurements, and plasma wave/planetary radio astronomy data.

SATURN RESULTS

Magnetosphere

Of the six planets in the solar system which have been studied so far at close range, five — Mercury, Earth, Mars, Jupiter, and Saturn — have intrinsic magnetic fields. These fields are generated by currents which flow in the interiors of the planets, and are mainly dipolar; i.e., current along the magnetic field lines flows from pole to pole.

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The magnetic field influences not only the planet, but a considerable area of space around the planet, as well. This area is called the magnetosphere. Saturn's magnetosphere extends outward from the planet nearly one million miles – making it about five times larger than Earth's magnetosphere but only one-third as large as Jupiter's. The rings, Mimas, Enceladus, Tethys, Dione, and Rhea are totally within the magnetosphere at all times, as are the small, newly-discovered satellites.

Although Saturn's largest satellite, Titan, is usually inside the magnetosphere, it is sometimes outside in the solar wind, due to fluctuations of the magnetospheric boundary. The size of the magnetosphere is influenced by increases or decreases in the intensity of the flow of charged particles streaming from the sun (the solar wind). Solar flares, for example, increase the solar wind intensity, but the effect may take several weeks to reach the outer planets.

At the time of Voyager 1's passage, Titan was inside Saturn's magnetosphere. The data are being studied to determine how the magnetosphere interacts with Titan and its thick nitrogen-rich atmosphere.

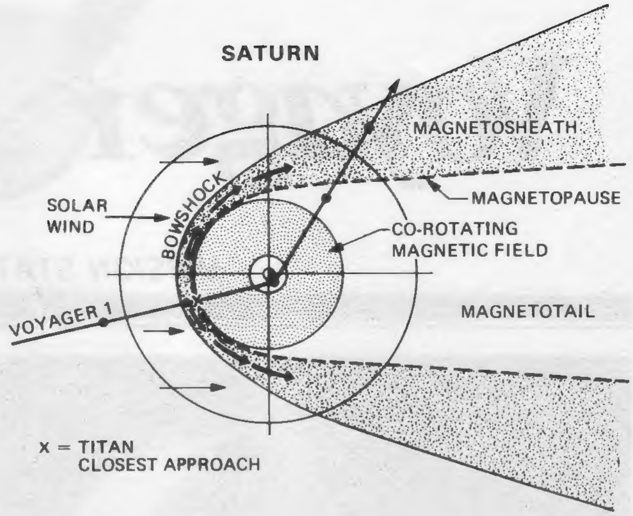
As is the case at Jupiter, charged particles in Saturn's magnetosphere are dragged along by the magnetic field and rotate with the planet at the planet's rotation rate – about 10 hours 40 minutes. At Titan, about 1.2 million kilometers from the planet's center, these particles speed past at almost 200 kilometers per second (447,000 miles per hour)! For comparison, particles in Jupiter's magnetic field are travelling about 77 kilometers per second (172,000 miles per hour) at Io's orbital distance.

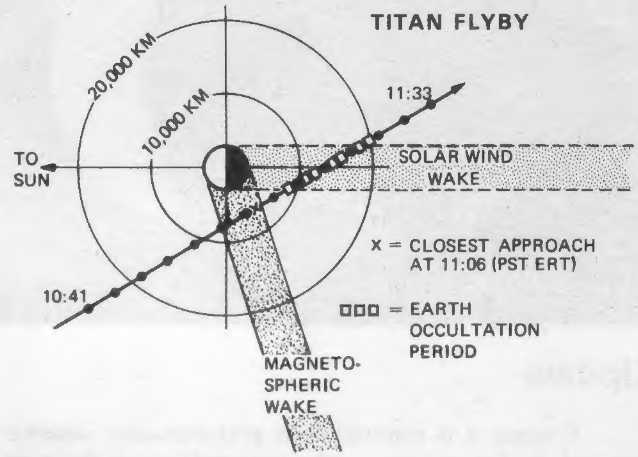
The flow of the co-rotating magnetosphere around Titan leaves a "wake" much like that left by a motorboat. Inside this wake region, the ions and electrons are colder, slower, and of higher density than the surrounding magnetospheric particles. Currents in this wake form a magnetic tail which extends in front of Titan as its orbits. The magnetosphere rotates faster than Titan does.

The source of particles in Saturn's magnetosphere is still under investigation. The low-energy charged particles (LECP) instrument's detection of fast-moving (7000 miles per second) molecular hydrogen in Saturn's magnetosphere suggests that Titan's atmosphere may be an important source. The LECP also found that the energies of fast ions in Saturn's magnetosphere are typically ten times less than those in Jupiter's.

Voyager 1 met Saturn's bowshock wave on November 11, about 1.572 million kilometers from the planet's center. The bowshock is the outer boundary of a planet's magnetic influence where particles streaming from the sun at supersonic speeds drop to subsonic speeds as they meet particles more influenced by a planet's magnetic field. The actual boundary of the co-rotating magnetosphere is called the magnetopause, and the area between the bowshock and magnetopause is the magnetosheath. After crossing the bowshock, Voyager 1 travelled through the magnetosheath and crossed the magnetopause five times in about an hour as this boundary also ebbed and flowed. The first magnetopause crossing was a little more than two hours after the bowshock crossing. The final inbound crossing of the magnetopause was about 1.374 million kilometers from Saturn's center.

As the solar wind streams around the planet and its magnetosphere, the magnetosphere stretches out into a tail – a magnetotail – behind the planet streaming *away* from the sun. Because of its curved flight path, Voyager 1





spent only a few days in Saturn's magnetotail, compared to several weeks in Jupiter's. The first outbound magnetopause crossing occurred November 14 about 2.580 million kilometers past the planet. By November 16 at 4.680 million kilometers, Voyager 1 passed out of Saturn's magnetic domain and back into the solar wind for good.

Satellites such as Titan and Jupiter's Io have been called naturally-occurring power stations. As Titan moves through Saturn's co-rotating magnetic field, its ionosphere acts as an armature to produce voltage and power. Voyager 1 measured these to be about 6000 volts and 20 megawatts, respectively. The magnetic field at the inner regions of Titan's wake is weaker than outside the wake. Titan probably has no intrinsic magnetic field, indicating that it does not possess a liquid, conducting core. If Titan does possess a magnetic field, it can be no stronger than one-tenth of one percent of Earth's magnetic field, or about 30 nano-Teslas, as measured by Voyager's magnetometers.

Surrounding Titan and its orbit and extending nearly a million kilometers inward toward the planet to the orbit of Rhea, the ultraviolet spectrometer detected an enormous, flattened cloud of uncharged hydrogen atoms forming a doughnut-like torus around the planet. These atoms do not rotate with the magnetosphere. The mass of the torus is estimated to be 25,000 tons and the density about 10 atoms per cubic centimeter.

At the planet, the rings appear to be an effective shield or absorber of charged particles, but in the process are affected themselves. The magnetic effects on the rings are evidenced by the B-ring spokes and lightning-like electrical discharges in the rings.